

	L #	Hits	Search Text	DBs	Time Stamp
1	L1	59	((ruthenium or Ru) near4 (gas or precursor or reactant)) or ((ruthenium or Ru) near4 (gas\$3 or precursor\$3 or reactant\$3))) same ((bis- cyclopentadienyl or bis- methylcyclopentadienyl or bis-ethylcyclopentadienyl or tris-dipivaloylmethanate or (bis adj cyclopentadienyl) or (bis adj methylcyclopentadienyl) or (bis adj ethylcyclopentadienyl) or (tris adj dipivaloylmethanate) or (Ru near2 ("CH.sub.3C.sub.5H.sub.4")) or (Ru near2 ("CH.sub.3C.sub.5H.sub.4")) or (Ru near2 ("C.sub.2H.sub.5C.sub.5H.su b.4")) or (Ru near2 ("C.sub.22H.sub.190.sub.2")) )))	US- PGPUB; USPAT; EPO; JPO; DERWEN T; IBM_TD B	2005/03/18 13:13
2	L2	1856	(ruthenium or Ru) near4 (gas\$3 or precursor\$3 or reactant\$3)	US- PGPUB; USPAT; EPO; JPO; DERWEN T; IBM_TD B	2005/03/18 13:13

	L #	Hits	Search Text	DBs	Time Stamp
3	L3	280168	"O.sub.2" or "N.sub.20" or "H.sub.20" or "NO.sub.2" or "O.sub.3"	US- PGPUB; USPAT; EPO; JPO; DERWEN T; IBM_TD B	2005/03/18 13:13
4	L4	726	L3 and L2	US- PGPUB; USPAT; EPO; JPO; DERWEN T; IBM_TD B	2005/03/18 13:13
5	L5	490	L4 and (@ad<"20010131") or (@rlad<"20010131"))	US- PGPUB; USPAT; EPO; JPO; DERWEN T; IBM_TD B	2005/03/18 13:13

	L #	Hits	Search Text	DBs	Time Stamp
6	L6	36	<p>         (((((ruthenium or Ru) near4          (gas\$3 or precursor\$3 or          reactant\$3)) or ((bis-          cyclopentadienyl or bis-          methylcyclopentadienyl or          bis-ethylcyclopentadienyl          or tris-dipivaloylmethanate          or (bis adj          cyclopentadienyl) or (bis          adj methylcyclopentadienyl)          or (bis adj          ethylcyclopentadienyl) or          (tris adj          dipivaloylmethanate) or (Ru          near2          ("CH.sub.3C.sub.5H.sub.4"))          or (Ru near2          ("CH.sub.3C.sub.5H.sub.4"))          or (Ru near2          ("C.sub.2H.sub.5C.sub.5H.su          b.4")) or (Ru near2          ("C.sub.22H.sub.190.sub.2")          ))) same ("O.sub.2" or          "N.sub.20" or "H.sub.20" or          "NO.sub.2" or "O.sub.3"))          and ((capacitor\$3 or DRAM          or (dynamic adj random adj          access adj memory) or          SDRAM))) and @py&lt;="2001"       </p>	US- PGPUB; USPAT; EPO; JPO; DERWEN T; IBM_TD B	2005/03/18 13:14

DOCUMENT-IDENTIFIER: US 20010054730 A1

TITLE: Metal-insulator-metal capacitor and  
manufacturing method thereof

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Abstract Paragraph - ABTX (1):

A metal-insulator-metal (MIM) capacitor of a semiconductor device, and a manufacturing method thereof, includes a lower electrode formed of a refractory metal or a conductive compound including the refractory metal, a dielectric film formed of a high dielectric material, and an upper electrode formed of a platinum-family metal or a platinum-family metal oxide. Accordingly, the MIM capacitor satisfies the criteria of step coverage, electrical characteristics and manufacturing costs, as compared to a conventional MIM capacitor in which the upper and lower electrodes are formed of the same material such as a platinum-family metal, a refractory metal or a conductive compound including the refractory metal. The capacitor is especially suitable for mass production in semiconductor fabrication processes.

Pre-Grant Publication Year - PGPY (1):

2001

Title - TTL (1):

Metal-insulator-metal capacitor and manufacturing method thereof

Summary of Invention Paragraph - BSTX (3):

[0002] The present invention relates to a capacitor for a semiconductor device and a manufacturing method thereof, and more particularly, to a capacitor having a metal-insulator-metal structure (hereinafter, referred to as a MIM capacitor) and a manufacturing method thereof.

Summary of Invention Paragraph - BSTX (5):

[0004] As semiconductor technology evolves, the area occupied by

Detail Description Paragraph - DETX (22):

[0049] The Ru upper electrode 190 is formed by CVD or ALD at 250 to 450.degree. C. while an Ru source gas obtained by vaporizing liquid Ru(C<sub>2</sub>H<sub>5</sub>C<sub>5</sub>H<sub>5</sub>N)<sub>2</sub>)<sub>2</sub> and an O<sub>2</sub> reaction gas are being supplied. The surface morphology and electrical characteristics of the Ru film vary according to the conditions for deposition. As disclosed in Korean Patent Application No. 99-61337 filed on Dec. 23, 1999 by the present applicant and incorporated herein by reference, the Ru upper electrode 190 having a desired property can be obtained by varying the deposition conditions over the early and late stages of deposition. In this case, to be more specific, at the early stage of deposition, ruthenium deposited for a time period ranging from 5 seconds to 5 minutes in a state where the pressure within the reaction chamber is maintained at 10 to 50 Torr, more preferably, at 20 to 40 Torr, and the flow of an O<sub>2</sub> gas is maintained at 500 to 2000 sccm, more preferably, at 1000 to 1500 sccm. At the late stage of deposition, ruthenium is deposited until an Ru film having a desired thickness is formed, by maintaining the pressure within a reaction chamber at 0.05 to 10 Torr, more preferably, at 0.1 to 3 Torr, and maintaining the flow of an O<sub>2</sub> gas at 10 to 300 sccm, more preferably, at 50 to 150 sccm.

Detail Description Paragraph - DETX (23):

[0050] In the modified embodiment of the present invention, as shown in FIG. 9, a Si<sub>3</sub>N<sub>4</sub> reaction prevention film 200 can be sandwiched between the lower electrode 162 and the dielectric film 180. In this embodiment, the silicon nitride film 200 is formed on the entire surface of the substrate of FIG. 7 on which the cylindrical TiN lower electrode 162 is formed, by CVD using a Si source gas such as a silane-family gas and an N source gas such as NH<sub>3</sub>. Next, the dielectric film 180 and the upper electrode 190

are formed on the resultant structure, thereby forming a capacitor according to this embodiment of the present invention. Here, preferably, the Si.<sub>3</sub>N<sub>4</sub> reaction prevention film 200 is deposited to be in an amorphous state at 600 to 700.degree. C., and the dielectric film 180 is thermally treated and crystallized after the upper electrode 190 is formed. If the crystallization of the Ta.<sub>20</sub>.sub.5 dielectric film 180 is performed before the Ru upper electrode 190 is formed, the Si.<sub>3</sub>N<sub>4</sub> reaction prevention film 200 operates as a crystallization seed layer of the Ta.<sub>20</sub>.sub.5 dielectric film 180, so that the dielectric constant of the Ta.<sub>20</sub>.sub.5 dielectric film 180 slightly increases. In contrast, when the crystallization of the Ta.<sub>20</sub>.sub.5 dielectric film 180 is performed after the Ru upper electrode 190 is formed, the Ru upper electrode 190 operates as a crystallization seed layer of the Ta.<sub>20</sub>.sub.5 dielectric film 180, so that the dielectric constant of the Ta.<sub>20</sub>.sub.5 dielectric film 180 increases substantially.

Detail Description Paragraph - DETX (24):

[0051] FIGS. 10 and 11 are graphs showing the accumulative distributions according to the electrical characteristics of a capacitor according to the embodiment of the present invention. In these experiments, a cylindrical capacitor having a CVD-Ru upper electrode/CVD-Ta.<sub>20</sub>.sub.5 dielectric film/CVD-TiN lower electrode structure is used, the height of the lower electrode is set to be about 1 .mu.m, and the thickness of the dielectric film is set to be about 150 .ANG..

Detail Description Paragraph - DETX (25):

[0052] Referring to FIG. 10, the capacitance of a capacitor according to the embodiment of the present invention is about 40 fF per cell, and the ratio of C<sub>min</sub>/C<sub>max</sub> is about 0.99. Referring to FIG. 11, when .+- .1 voltage

was applied, a good leakage current density, about  $10. \sup{-16}$  A per cell, was measured.

Detail Description Paragraph - DETX (26):

[0053] In the above-described embodiments, upper and lower electrodes and a dielectric film are formed by depositing a particular material using a particular method. However, if a source gas is appropriately selected, other materials mentioned above can be used. In cases of capacitors not having a three-dimensional shape such as a cylindrical shape, it is apparent that the upper and lower electrodes and the dielectric film can be formed by other methods such as sputtering.

Detail Description Paragraph - DETX (27):

[0054] As described above, in capacitors using a high dielectric material to form a dielectric film, according to the present invention, a lower electrode is formed of a refractory metal or a conductive compound containing the refractory metal, the deposition and etching of which are put into practical use, so that a three-dimensional lower electrode can be formed with excellent step coverage. Also, an upper electrode is formed of a platinum-family metal or a platinum-family metal oxide, so that a capacitor having superior electrical characteristics can be obtained.

Detail Description Paragraph - DETX (28):

[0055] Also, an MIM capacitor according to the present invention satisfies the step coverage, the electrical characteristics and manufacturing costs, compared to a conventional MIM capacitor in which the upper and lower electrodes are formed of the same material such as a platinum-family metal, a refractory metal or a conductive compound including the refractory metal. In particular, by developing and applying a new CVD method to deposit a platinum-family metal such as Ru, which heretofore has had no practical deposition methods, the electrical characteristics of a capacitor can be

guaranteed. Accordingly, the capacitors according to the present invention can be mass-produced.

Claims Text - CLTX (2):

1. A capacitor comprising: a lower electrode formed of a refractory metal or a conductive compound including the refractory metal; a dielectric film formed of a high dielectric material on the lower electrode; and an upper electrode formed of a platinum-family metal or a platinum-family metal oxide on the dielectric film.

Claims Text - CLTX (3):

2. The capacitor of claim 1, wherein the refractory metal is one selected from the group consisting of Ti, Ta and W, and the conductive compound including the refractory metal is one selected from the group consisting of TiN, TiSiN, TiAlN, TaN, TaSiN, TaAlN and WN.

Claims Text - CLTX (4):

3. The capacitor of claim 1, wherein the dielectric film is a single film or a composite film, and is formed of at least one material selected from the group consisting of Ta<sub>20</sub>.sub.5, Al<sub>20</sub>.sub.3 and TaON.

Claims Text - CLTX (5):

4. The capacitor of claim 1, wherein the platinum-family metal is one selected from the group consisting of Ru, Pt and Ir, and the platinum-family metal oxide is one selected from the group consisting of RuO<sub>2</sub>, PtO and IrO<sub>2</sub>.

Claims Text - CLTX (6):

5. The capacitor of claim 1, further comprising a reaction prevention film between the lower electrode and the dielectric film to prevent the reaction between the material of the lower electrode and that of the dielectric film.

Claims Text - CLTX (7):

6. The capacitor of claim 5, wherein the reaction prevention film

is formed  
of a material selected from the group consisting of Si.<sub>3</sub>N<sub>4</sub>,  
Al.<sub>20</sub>.<sub>3</sub>, TaON, HfO.<sub>2</sub> and ZrO.<sub>2</sub>.

Claims Text - CLTX (8):

7. A capacitor comprising: a cylindrical lower electrode formed of TiN; a dielectric film formed of Ta.<sub>20</sub>.<sub>5</sub> on the lower electrode; and an upper electrode formed of CVD-Ru on the dielectric film.

Claims Text - CLTX (9):

8. The capacitor of claim 7, further comprising a Si.<sub>3</sub>N<sub>4</sub> reaction prevention film between the lower electrode and the dielectric film to prevent the reaction between the material of the lower electrode and that of the dielectric film.

Claims Text - CLTX (10):

9. A method of manufacturing a capacitor, comprising: forming a lower electrode of a refractory metal or a conductive compound including the refractory metal on a substrate; forming a dielectric film of a high dielectric material on the lower electrode; and forming an upper electrode of a platinum-family metal or a platinum-family metal oxide on the dielectric film.

Claims Text - CLTX (16):

15. The method of claim 9, further comprising thermally treating the capacitor, after the step of forming an upper electrode.

Claims Text - CLTX (21):

20. A method of manufacturing a capacitor, comprising: forming a cylindrical lower electrode by chemical vapor depositing TiN on a substrate; forming a dielectric film of Ta.<sub>20</sub>.<sub>5</sub> on the lower electrode; and forming an upper electrode by chemical vapor depositing Ru on the dielectric film.

Claims Text - CLTX (23):

22. The method of claim 20, further comprising thermally treating the

capacitor, after the step of forming an upper electrode.